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# New England Groundfish

*“... there was no sound except the splash of the sinkers overside, the flapping of the cod, and the whack of muckles as the men stunned them. It was wonderful fishing.”*

—Rudyard Kipling  
“Captains Courageous”

## INTRODUCTION

Some groundfish resources off New England are now recovering from record low stock sizes and landings observed in the early 1990's. Other stocks, however, continue to decline because of excessive fishing mortality and below-average recruitment. Declines in some stocks occurred steadily over time, while others happened more recently and abruptly. Resources more sensitive to overfishing declined and were supplanted by other target species in a sequential pattern of resource exploitation. The New England groundfish fishery is now supported by species most resilient to exploitation and others not heretofore considered marketable. Groundfish resources and their dependent fisheries are well documented by landings statistics dating back over a century, and by standardized research vessel survey efforts which began over 3 decades ago. This article reviews the history of the New England groundfish fishery, its management, and prospects for long-term recovery and sustainability.

## BACKGROUND

New England has been identified economically and culturally with the harvest of groundfishes, for over 400 years. A mixture of bottom-dwelling species including Atlantic cod, haddock, redfish, hakes, and flounders constitute the groundfish

resource (Table 1). The complex history of the region's groundfish resources and their exploitation can be defined into several unique stanzas since the turn of the century. Some of the important technological developments and resource conditions associated with these various stanzas are described below.

## Conversion from Sail to Steam (1900–20)

In the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, large fleets of sailing vessels from Gloucester, Boston, and other New England ports ranged throughout the coastal areas and offshore banks from Cape Cod to the Grand Banks off Newfoundland (Figure 1). Atlantic cod catches, primarily for salt cod, supported over 800 dory schooners and a multitude of shore-side businesses, including salt mining, ice harvesting, and an active boat-building industry, necessitated by substantial losses of both ships and men to the vagaries of the North Atlantic. The catch from distant fishing grounds was generally salted (schooners fishing with these methods were termed “salt bankers”), while catches from the Gulf of Maine and Georges Bank, by schooners called “market” or “shack” boats, were generally stored on ice and sold fresh.

At the turn of the 20<sup>th</sup> century, major technological innovations were introduced which changed how fish were caught, handled, processed,

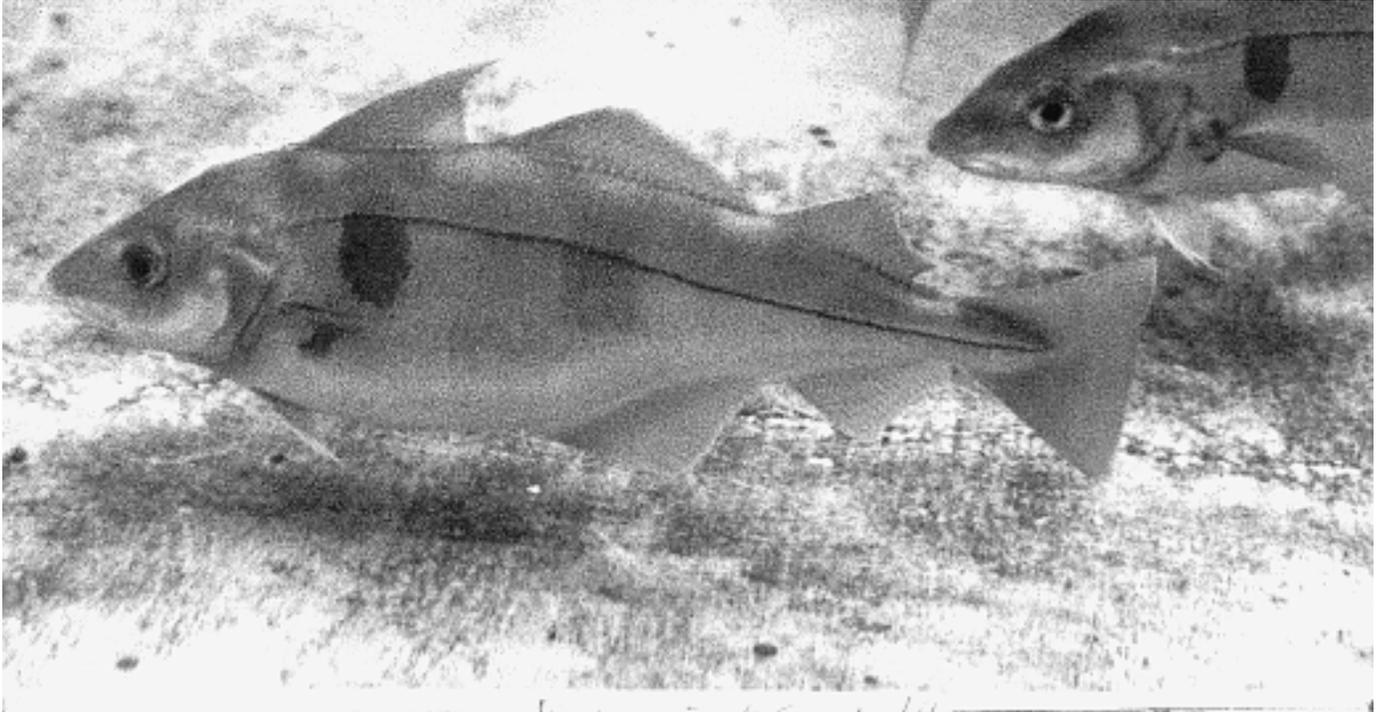
# Feature Article 2

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STEVEN A. MURAWSKI  
RUSSELL W. BROWN  
STEVEN X. CADRIN  
RALPH K. MAYO  
LORETTA O'BRIEN  
WILLIAM J. OVERHOLTZ  
KATHERINE A. SOSEBEE

NMFS Northeast Fisheries  
Science Center  
Woods Hole  
Massachusetts

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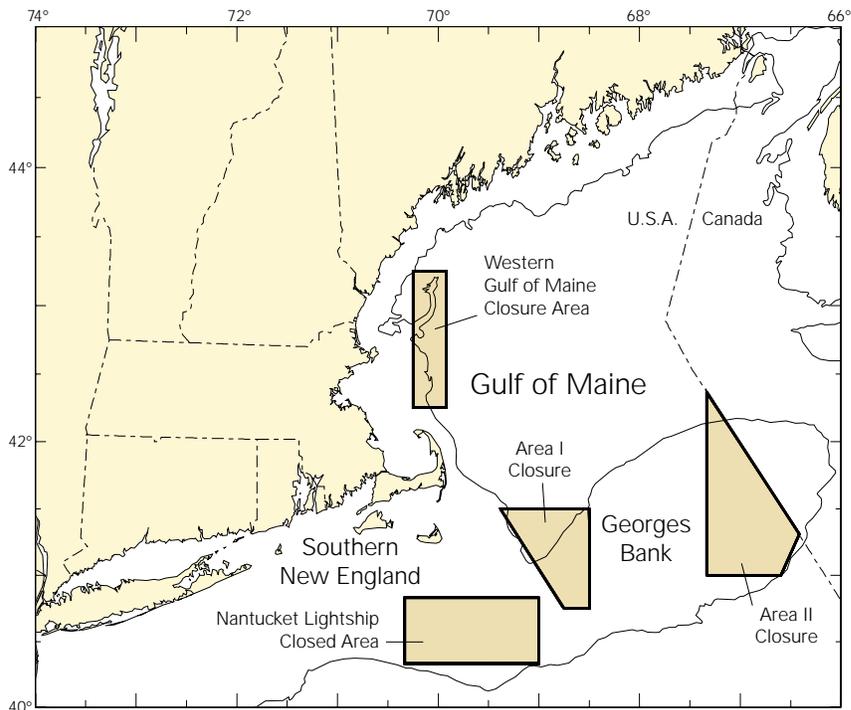


Haddock

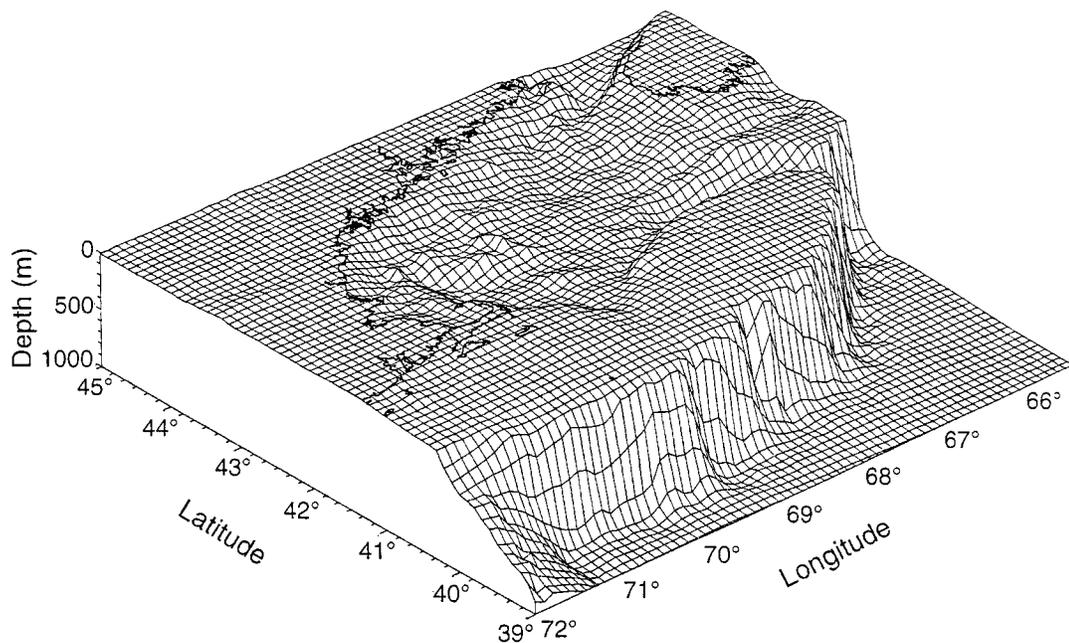
**Table 1**

Species and stocks comprising the New England groundfish resource. Stocks that are regulated as part of the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (FMP) are indicated.

Common name	Management stocks	Part of NE FMP?
Atlantic cod	Georges Bank; South Gulf of Maine	Yes
Haddock	Georges Bank; Gulf of Maine	Yes
Ocean perch (Acadian redfish)	Gulf of Maine	Yes
Pollock	Gulf of Maine	Yes
White hake	Gulf of Maine	Yes
Red hake	Gulf of Maine and North Georges Bank; South Georges Bank and Middle Atlantic	Yes
Silver hake	Gulf of Maine and North Georges Bank; South Georges Bank and Middle Atlantic	Yes
Ocean pout	Gulf of Maine and South New England	Yes
Atlantic halibut	Gulf of Maine	Yes
Winter flounder	Georges Bank; Gulf of Maine; South New England	Yes
Witch flounder	Gulf of Maine	Yes
Yellowtail flounder	Georges Bank; South New England; Cape Cod; Middle Atlantic	Yes
American plaice	Gulf of Maine	Yes
Windowpane	Gulf of Maine and North Georges Bank; South Georges Bank and South New England	Yes
Cusk	Gulf of Maine	No
Atlantic wolffish	Gulf of Maine	No
Spiny dogfish	Northeast United States and Canada	No
Skates (seven species)	Gulf of Maine and Middle Atlantic	No
Goosefish (monkfish)	Gulf of Maine and North Georges Bank; South Georges Bank and Middle Atlantic	No
Summer Flounder	Georges Bank and Middle Atlantic	No



**Figure 1**  
Geographic areas occupied by New England groundfish stocks. Four areas are outlined that are currently closed to fishing with gears capable of catching groundfish.





**Figure 2**  
Otter trawl vessels at Boston Fish Pier, ca. 1931. At the end of the pier is the *Spray*, built in 1905, the first steam trawler in the New England groundfish fleet.



distributed, and sold. The introduction of better handling (filleting and freezing) and distribution methods (train, refrigerated storage) meant that fresh and frozen fish could be sold in markets across the country, thereby reducing the dominance of salt cod as a preferred product.

Steam-powered trawl vessels, introduced to harvest flounders and haddock on smooth-bottom areas, rapidly replaced the traditional sailing schooners. The first trawler, *Spray*, was introduced in Boston in 1906 (Figure 2), and the trawler fleet quickly grew to over 300 vessels by 1930. Steam power was supplanted by diesel power after World War I. The transition to otter trawling as the dominant fishing method was, however, not without controversy. Objections to development of the otter trawl fishery centered on the potential for ecological damage to bottom-dwelling animals and plants, and economic competition with existing fixed-gear fisheries. Management recommendations resulting from scientific investigations of the "trawler problem" included delimiting areas where trawls could and could not be used; however, these recommendations were not implemented. Even before 1900, some species, especially the Atlantic halibut (Figure 3), showed signs of decline due to overfishing by hook-and-line fisheries. Halibut landings had begun to decline by the 1850's, and by the 1890's almost all of the Atlantic halibut sold in Gloucester came from Iceland. Pacific halibut were shipped to Boston via train by the turn of the century. Overfishing and resource decline would accelerate with the increased intensity of the fisheries and the expanding list of target species.

**Figure 3**  
Unloading Atlantic halibut, ca. 1930, at the Boston Fish Pier. Note traditional dories nested together aboard the vessel in the foreground.

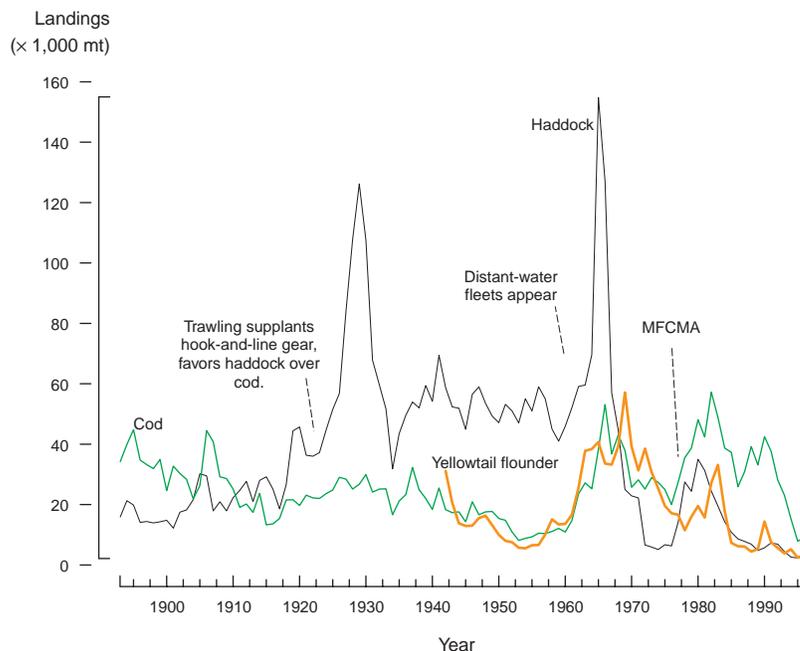
### The Rise of the Trawl Fishery (1920–60)

The species composition of groundfish landings changed dramatically following the introduction of trawling, as the trawl fishery targeted haddock rather than cod (Figure 4) and then expanded to other stocks. Prior to 1900, haddock landings were relatively low (~20,000 metric tons (t)/year) since the species did not preserve well when salted. By the late 1920's, haddock landings increased to over 100,000 t (Figure 4). This level of catch, however, was not sustainable, and landings (primarily from Georges Bank) would plummet in the early 1930's.

By 1930 the groundfish fleet had grown too large relative to the natural capacity of the haddock stocks to produce increased yields. Growth overfishing was revealed by sampling of the catches by at-sea observers. In 1930, 37,000,000 haddock were landed at Boston, but an estimated 70,000,000–90,000,000 juvenile haddock were discarded dead at sea, due to the very small mesh used in the otter trawl nets. Surprisingly, mesh-size regulations to protect haddock would not be implemented until 1953.

The crash in Georges Bank haddock landings prompted a great deal of new research to investigate the causes and recommend new management measures. Modern research programs to study the population dynamics and demographics of New England groundfish date back to work begun in the 1930's by William Herrington and his colleagues at Harvard University and the U.S. Bureau of Commercial Fisheries (forerunner to the National Marine Fisheries Service). Owing partly to a shift of the fishery to resources on Browns Bank off Nova Scotia, the Georges Bank haddock resource recovered in the mid 1930's, and landings subsequently averaged about 50,000 t/year between 1935 and 1960 (Figure 4). Haddock remained the mainstay of the New England groundfish fishery until the mid 1960's. Cod landings generally remained stable throughout the 1915–40 period, as haddock, redfish, and other species were the species of primary interest to consumers (Figure 4).

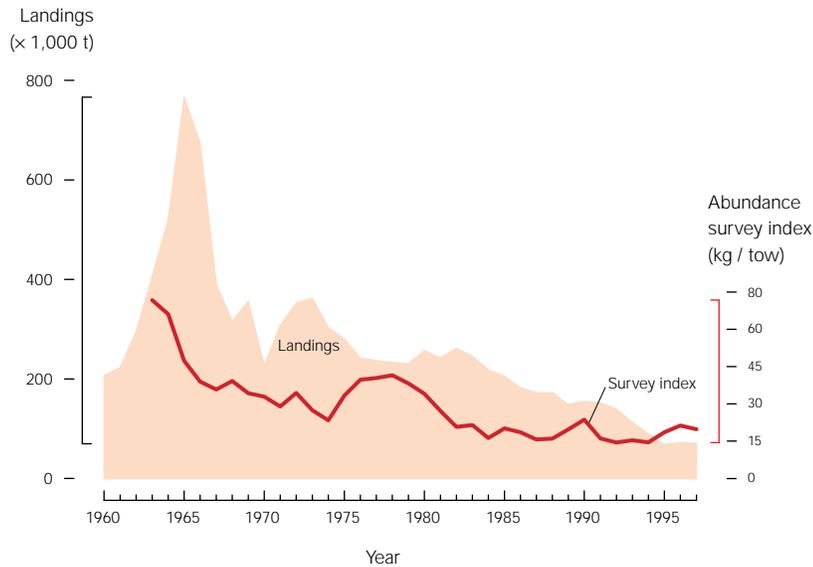
The war years (World War II) were prosperous for the industry as fish was canned for mili-



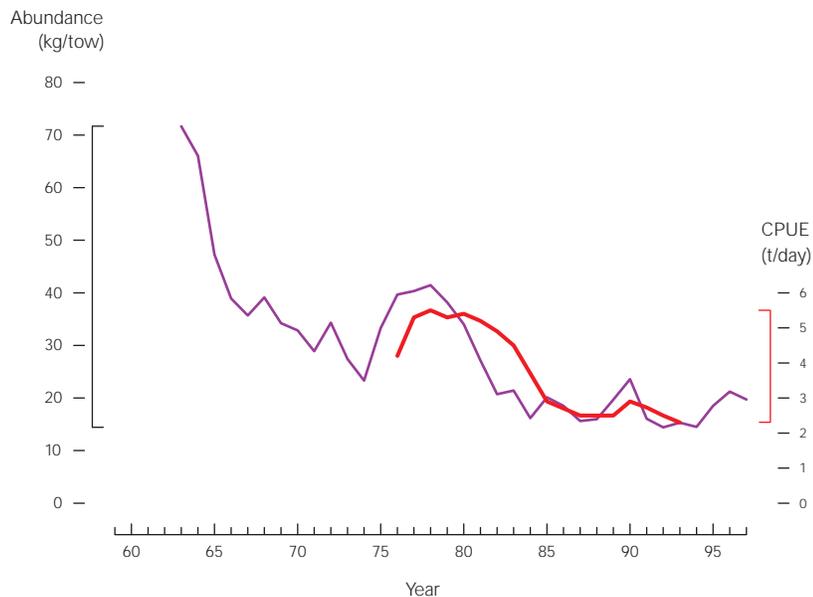
**Figure 4**  
Total landings (× 1,000 t) of Georges Bank cod and haddock, and landings of yellowtail flounder from all New England waters, 1893–1997.

tary use, and protein demands and rationing necessitated increased fish consumption at home. The fleet was also reduced at this time, as many of the largest trawlers were requisitioned for war duty as mine sweepers. Development of new markets (i.e. for ocean perch (redfish), which was later marketed in the midwestern United States as a substitute for Great Lakes yellow perch) sustained a portion of the offshore fleet during the war years. Many government subsidy programs were launched after the war when demand for groundfish declined.

The redfish fishery began in the 1930's, peaked in U.S. waters by the 1940's and expanded eastward to the Scotian Shelf, growing to about 120,000 t/year during the early 1950's. This long-lived, slow-growing resource was fished down to moderate levels in the Gulf of Maine during the 1930's and 1940's, and the stock collapsed following the return of the fleet from Canadian waters in the mid 1970's. Flatfish landings were dominated by catches of winter flounder, witch flounder, and American plaice until the 1940's. Thereafter, yellowtail flounder became the most important flatfish of New England, but it declined greatly in abundance and landings through the 1940's and 1950's (Figure 4). Reasons for the yellowtail flounder decline during this period are not known, but



**Figure 5**  
Landings ( $\times 1,000$  t) and relative abundance (stratified mean catch per tow in kg from NEFSC bottom trawl surveys) for principal groundfish and flounder stocks off the U.S. northeast, 1960–97.



**Figure 6**  
Relative abundance (from stratified mean catch per tow in kg from NEFSC bottom trawl surveys) and commercial trawler CPUE (catch per unit of effort, in metric tons per day fished, standardized for vessel size) for principal groundfish and flounder stocks off the U.S. northeast, 1963–97.

recruitment declined steadily during the period. Other important groundfish stocks supporting the fishery prior to the 1960's included silver hake and pollock, with small amounts of red hake, white hake, and others. Because of the modest harvest rates on most stocks, recruitment overfishing did not occur or was not persistent. When stocks declined, the fleet moved to other species, or to different stocks of the same species (e.g. off Canada).

### Distant-Water Fleets (1960–76)

The growth of distant-water foreign fishing off the northeastern United States in the early 1960's included fleets of factory-based trawlers from eastern Europe, Asia, and elsewhere. Scouting vessels for the Soviet fleets first ventured into New England waters in 1961. Their initial target was Atlantic herring, and the distant-water fleet caught about 63,000 t that year. In subsequent years, herring catches increased (peaking at 225,000 t in 1963), and other species were also targeted, including silver and red hake, haddock, and Atlantic mackerel. From 1960 to 1965, total groundfish landings increased from 200,000 t to about 760,000 t (Figure 5). Haddock landings reached a record-high 154,000 t in 1965 and declined rapidly thereafter. Between 1964 and 1967 total groundfish landings were composed primarily of silver hake, haddock, red hake, flounders, and cod.

The intensified international fishery off the northeastern United States prompted the development of systematic multispecies monitoring surveys, which were initiated in the autumn of 1963. Stratified-random bottom-trawl surveys of the continental shelf waters from Nova Scotia to Hudson Canyon and later to Cape Hatteras, North Carolina, have been conducted every autumn since 1963 and every spring since 1968. Abundance, measured by these surveys, declined rapidly as various components of the demersal and pelagic systems were pulse-fished<sup>1</sup> (Figures 5 and 6). The parallel decline in groundfish abundance and landings was rapid and severe between 1966 and 1970 (Figure 5).

Beginning in 1970, quota-based management

<sup>1</sup>Intermittent, high fishing effort.

was instituted for the offshore New England waters under the auspices of the International Commission for the Northwest Atlantic Fisheries (ICNAF). Quotas for each species were allocated by country, with the sum of each species equal to the total recommended removals. Additionally, second-tier quotas, less than the sum of a country's species allocations, were intended to mitigate the effects of nontarget bycatch, so that species quotas would not be exceeded. The quota system under ICNAF effectively ended directed distant-water fisheries on New England groundfish resources, as these resources were determined to have little capacity to support fisheries beyond the levels that would be taken by the United States and Canada. Quotas were progressively lowered on mackerel, herring, longfin and shorfin squids, and other species, as these resources declined as well.

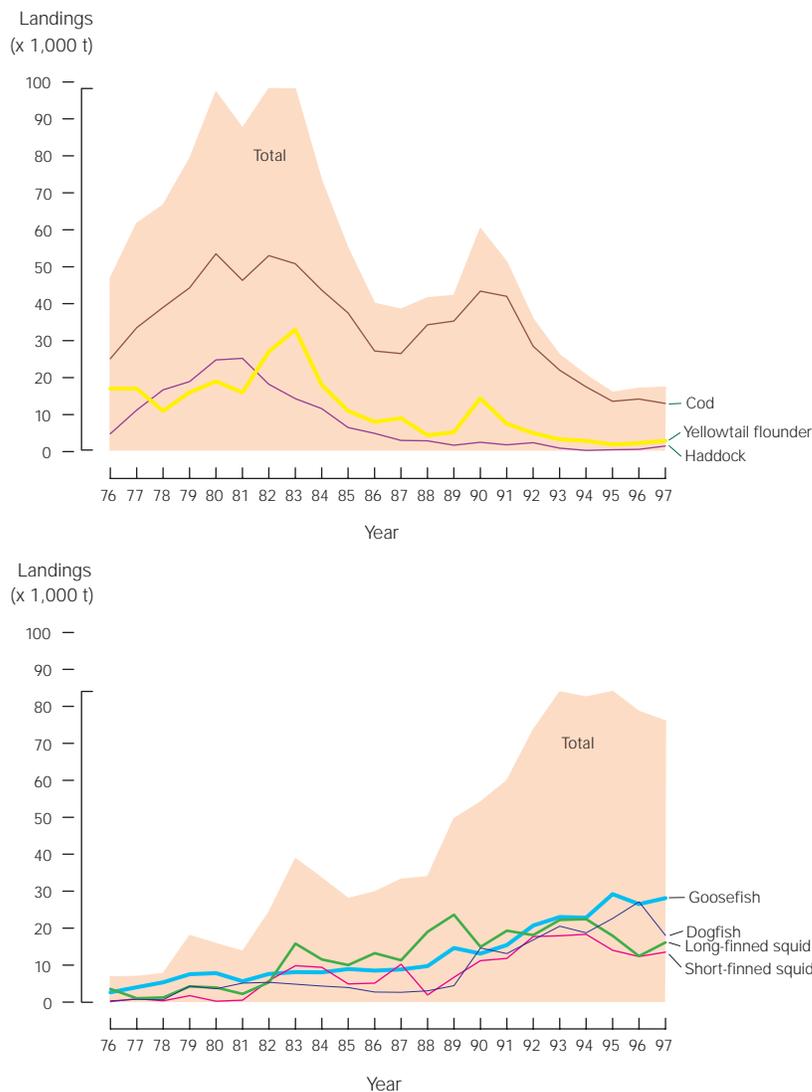
In response to the declining abundance and landings of traditional New England offshore resources and elsewhere, the Magnuson Fishery Conservation and Management Act (MFCMA) was promulgated in 1976. This measure effectively ended distant-water fleet participation in New England fisheries, although some countries were allowed to harvest surpluses of squids, hake, butterfish, and mackerel for a few years following enactment.

### Groundfish Fisheries Under the Magnuson Act (1976–99)

*“No one knew exactly how many newcomers had arrived during the last four months of 1977, but according to one report, new boats entered the fishery at the astounding rate of about one every four days.”*

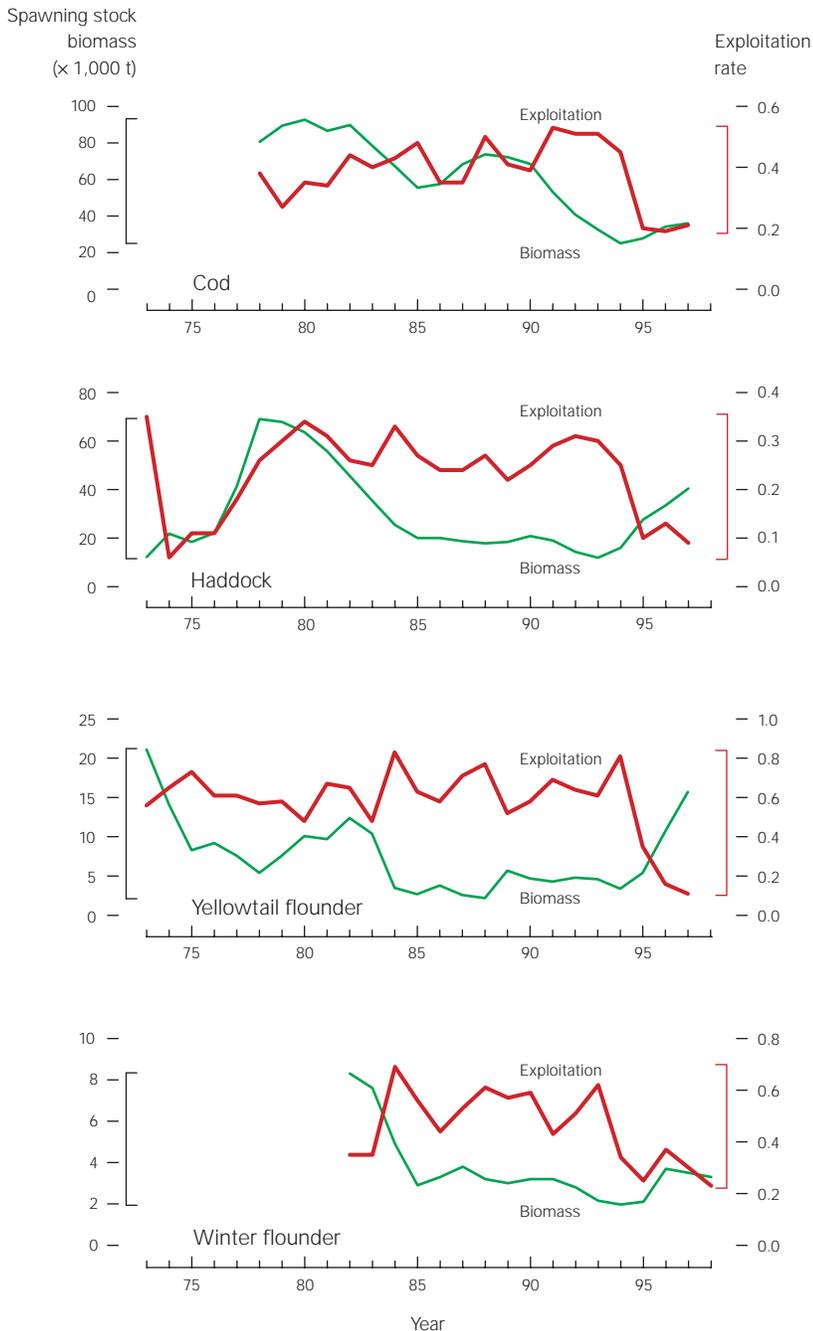
—Margaret Dewar  
“Industry in Trouble”

With the implementation of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1977, the northeast U.S. groundfish fleet, once dominated by wooden side-trawlers, was replaced relatively quickly by steel stern-trawlers equipped with more modern technology for locating, catching, and handling fish. Relatively strong year classes of cod, haddock, and some other



**Figure 7**  
U.S. landings (x 1,000 t) of cod, haddock, and yellowtail flounder (top panel) and goosefish, spiny dogfish, shortfin squid and longfin squid, (bottom panel), 1976–97.

groundfish stocks were produced in 1975, and they later resulted in improved resource conditions and increased groundfish abundance and effort in the late 1970's and early 1980's (Figures 5 and 6). As a result of the elimination of the distant-water fleets, U.S. and Canadian fishing effort off New England expanded rapidly. Between 1976 and 1984, U.S. otter-trawl fishing effort doubled. Fishery landings expanded quickly, with the Georges Bank component of the landings dominated by cod, haddock, and yellowtail flounder (Figure 7). Trends in groundfish trawler catch per unit of effort (CPUE in metric tons per day fished) paralleled the abundance indices from research vessel surveys (Figure 6). Catch rates increased rapidly



**Figure 8**  
Spawning stock biomass ( $\times$  1,000 t) and exploitation rate for four Georges Bank groundfish stocks, 1973–98.

after 1976, but by the early 1980's they had peaked and began to decline. By the mid 1980's, commercial catch rates had dropped by half, as had the overall abundance of the resource. The collapse of the Georges Bank haddock stock, and then Georges Bank and Southern New England yellowtail flounder resources, resulted in an almost complete reliance by the fishery on cod (Figure 7).

Reduced landings of the traditional groundfish stocks, combined with strong market demand for fish, prompted the development of fisheries for alternative species such as squids, spiny dogfish, skates, and goosefish (monkfish) (Figure 7). Exploitation rates of most groundfish resources rose significantly, and spawning stock biomasses declined (Figures 8–10).

The New England Fishery Management Council initially retained the quota-based fishery management system for groundfish it inherited from the earlier management schemes adopted by ICNAF, but eventually abandoned direct controls on fishing mortality in 1982 in favor of regulations based primarily on minimum mesh and fish sizes and other indirect fishery controls.

In addition to increases in domestic fishing effort, delimitation of the maritime boundary between the United States and Canada in 1985 ended fishing by New England fleets on the eastern portion of Georges Bank and on the Scotian Shelf off Canada and resulted in even greater pressure on stocks in U.S. waters.

Exploitation rates of groundfish reached their highest levels in the early 1990's, as stock biomasses fell, in many cases, to record lows (Figures 8–10). Indirect controls had not resulted in sufficient conservation of the resources, and environmental groups sued the U.S. Department of Commerce over this failure. What emerged was a series of fishery management plan amendments, first implemented in 1994, that reduced days at sea by all fleet sectors to 50% of the pre-1994 levels. Additionally, these amendments closed over 5,000 square nautical miles of prime groundfishing areas (Figure 1), increased minimum net mesh sizes, implemented a moratorium on vessel entrants, and required mandatory vessel and dealer reporting of catches. The new regulations also implemented trip limits to reduce catches of depleted species and instituted "target" total allowable catches (TAC's) to serve as a guide to measure the effectiveness of conservation measures. Reacting to the implementation of direct controls on fishing effort, Congress instituted a buyout of fishing effort which resulted in a fleet reduction of 79 groundfishing vessels.

As a result of management measures enacted since 1994, exploitation rates, particularly on

Georges Bank groundfish stocks, have declined to levels not seen in several decades (Figure 8). Modest increases in spawning stock biomass for Georges Bank cod and haddock have occurred. Georges Bank yellowtail flounder biomass has rebounded the fastest to levels not seen since the early 1970's. Continued rebuilding of these stocks is contingent on improved recruitment, which has occurred for Georges Bank yellowtail flounder and, apparently, in 1998 for haddock, but continues to be poor for most other groundfish stocks.

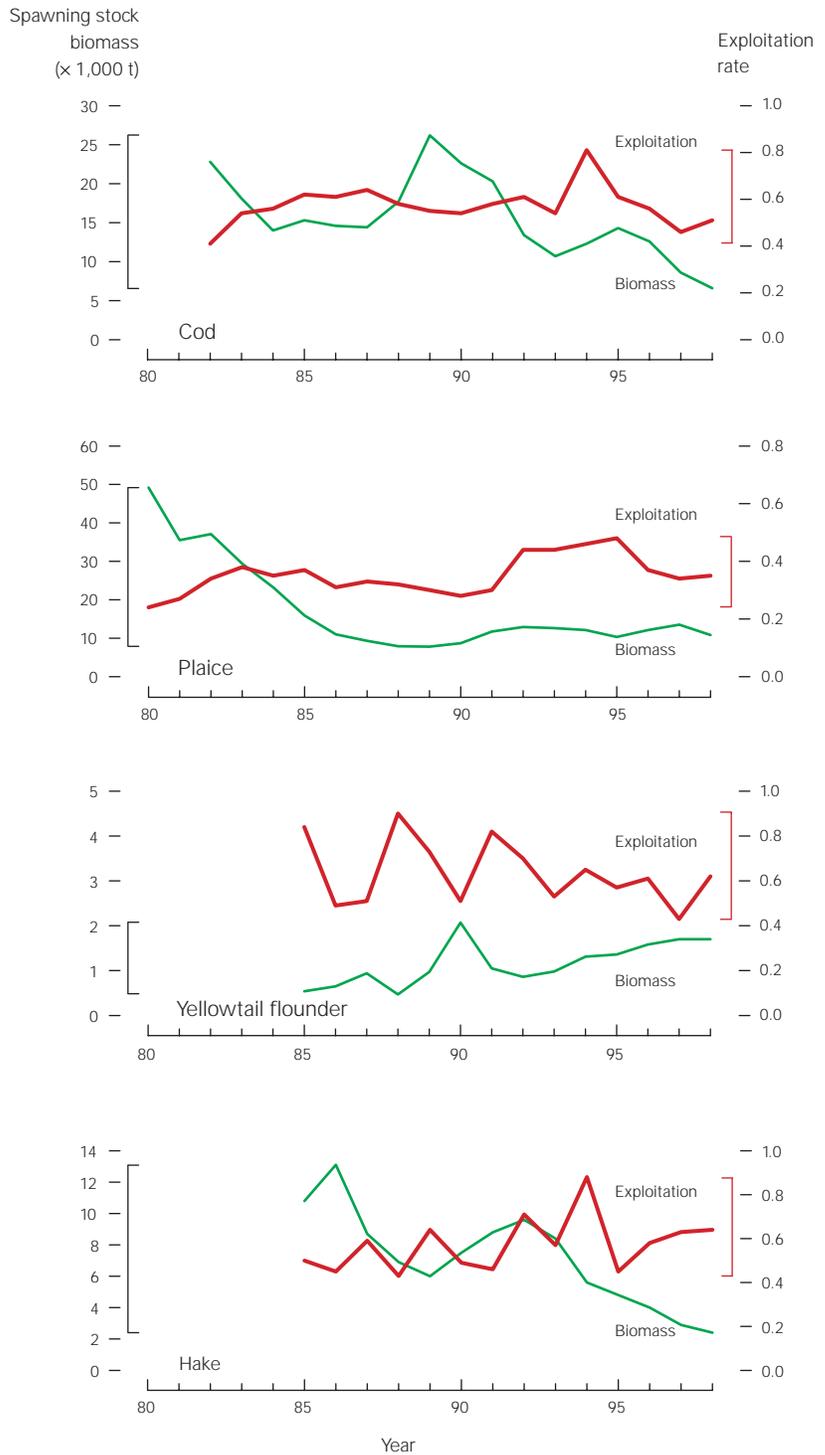
In the Gulf of Maine, exploitation rates have remained high, while spawning biomasses of cod, American plaice, and white hake have declined to near record lows (Figure 9). The lack of success in reducing exploitation for Gulf of Maine groundfish is due to several factors. Overall, groundfish effort has declined substantially; however, the large closed areas on Georges Bank (Figure 2), combined with days-at-sea regulations, have resulted in displacement of fishing effort to inshore areas and a concentrations of trawl, gillnet and hook activity in the nearshore fishing grounds of the Gulf of Maine. Recruitment to most major groundfish stocks in the Gulf of Maine region has been below average in recent years.

Exploitation rates for Southern New England flatfishes (winter and yellowtail flounder) have declined substantially since 1992 (Figure 10). The spawning biomass for winter flounder has increased more than twofold over the time series low observed in 1994. Biomass of yellowtail flounder, although increasing, is well below levels necessary to sustain a significant fishery (Figure 10).

Overall, the New England groundfish resource is beginning to increase in abundance (Figure 6), and exploitation rates for many of the key stocks are at levels which should allow stock rebuilding. Recruitment has been generally poor in recent years, and exploitation of some stocks (e.g. in the Gulf of Maine) remains excessive.

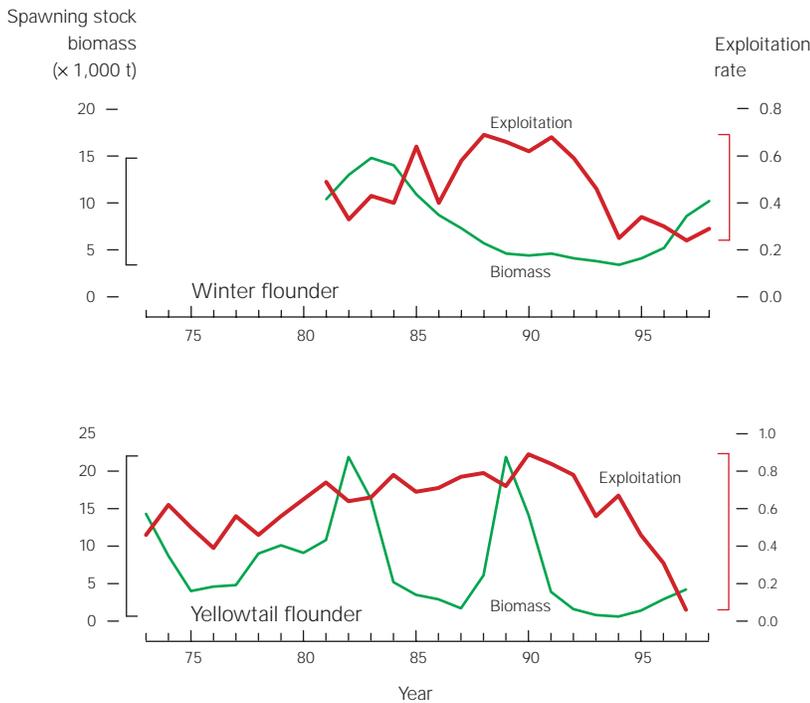
**PROSPECTS FOR THE RESOURCE AND FISHERY**

Groundfish abundance and landings from the offshore New England region have varied considerably over the past 100 years, primarily due to their exploitation history. Dramatic reductions in



**Figure 9** Spawning stock biomass (x 1,000 t) and exploitation rate for four Gulf of Maine groundfish stocks, 1980-98.

most offshore stocks occurred due to the distant-water fleets, who pulse-fished the wide array of available species. After elimination of the foreign fleets, some stocks rebounded to high levels, only to be overfished again by domestic fleets in the



**Figure 10**  
Spawning stock biomass ( $\times$  1,000 t) and exploitation rate (U) for two southern New England groundfish stocks, 1973–98.

1980's and early 1990's.

Projections of stock recovery included in recent groundfish fishery management plan amendments indicate that under exploitation rates such as those observed currently for Georges Bank stocks, recovery times of about a decade were required for most species, with some stocks rebuilding sooner (yellowtail flounder) and some later (haddock). This process has clearly begun on Georges Bank and in Southern New England, but additional conservation measures are required for many Gulf of Maine stocks. Managers are currently evaluating specific proposals for additional closed areas, effort reductions, and other measures to meet these goals.

Passage of the Sustainable Fisheries Act of 1996 has placed stringent new requirements for conservation and management of all fishery resources, including New England groundfish. The new stat-

ute requires that overfished populations be rebuilt to levels that would produce maximum sustainable yields over the long term. Current rebuilding target exploitation rates for New England groundfish will, in many cases, also be the long-term management goals required under the new law.

Management measures enacted since 1994 have had significant positive benefits for many of the resources, reflected in reduced exploitation rates, increased spawning stock sizes, and more balanced population age and size structures. One factor implicated in the decline of many groundfish stocks was the increased reliance on first-time spawners, a consequence of high and increasing exploitation rates. Reduced effort on some stocks has resulted in greater proportions of fish spawning two or more times before capture. A more balanced age structure is an important element rebuilding stocks (and fisheries) that can sustain normal year-to-year variations in recruitment, which may be extreme. Likewise, closed areas have been beneficial in promoting the recovery of the western Georges Bank spawning components of cod and haddock, which were fished to very low levels prior to 1995.

The New England groundfish resource has shown remarkable resiliency to changes in fleet size, target species shifts, and technological change over the past century. However, in some cases, stocks sensitive to overfishing (halibut, redfish) were "written-off" in favor of more productive resources. New fishery management legislation (i.e. the Sustainable Fisheries Act of 1996) requires that depleted resources be restored, and currently productive resources remain so. Fishing at sustainable exploitation rates will eventually result in much higher yields with less year-to-year variation in landings, more diverse catches (flounders, cod, haddock, redfish, pollock, etc.), and more stable catch rates in the fishery.